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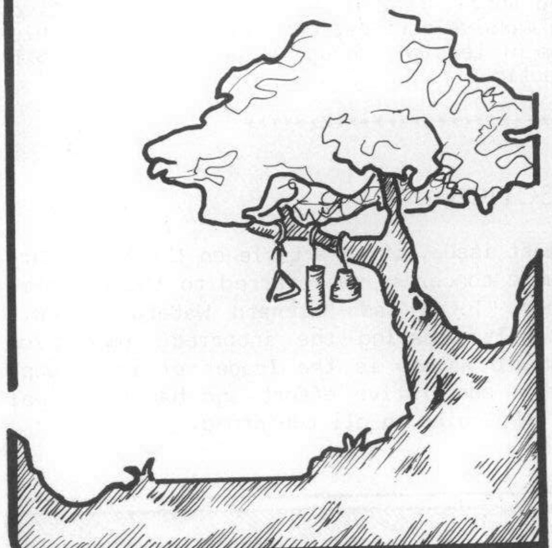

EXPERIMENTAL MUSICAL INSTRUMENTS

FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF NEW SOUND SOURCES

This issue of **Experimental Musical Instruments** contains a slight departure from past practice. For the first time we are running an article on an improved design for a standard instrument -- an improvement which does not effect the instrument's repertoire or technique, but enhances its ability to do what it was always meant to do. It is based on an extraordinary approach to soundboard design. A short introduction to the new idea appears below, followed by an article starting on page 3 written by one of the people closely associated with the new design's development.

In addition to that you will find in this issue the usual eclectic mix of articles and features relating to new instruments. One piece promised last time to appear in this issue -- the description of an instrument called Disorderly Tumbling Forth built by yours truly, EMI editor Bart Hopkin -- has been axed due to space problems. It will appear in one of the coming issues.

Now, on to the exposition of that remarkable soundboard.

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THE BI-LEVEL GUITAR

Designed by Roger Pytlewski along with Wayne Harris, David Millard, Robert Mattingly, David Dart and others.
Patent held by Roger Pytlewski.
Prototypes built by various luthiers; soon to be marketed by La Jolla Luthiers & Mfg. Co.

The bi-level guitar is a guitar like other guitars, made to play the same music by means of the same technique as conventional guitars, but with a newly-designed and radically different soundboard. As you can see in the illustrations accompanying the following article, the wood of the soundboard has two sharp bends running across its surface perpendicular to the strings. The soundboard over the upper bout is flat as usual, as is that over the lower bout, but the short portion of the board between the bends slopes at an angle of about 22 degrees. The entire lower bout, as a result, is an inch or so higher than

(Continued on page 3)

IN THIS ISSUE

LETTERS

I just received the three first issues of E.M.I. What a beautiful job you are doing! I admire the quality and quantity of work you have been putting into it.

It is just the magazine I have been waiting for since 1950.

Congratulations! (with a little touch of envy)

More after reading the three copies...

Francois Baschet

****

Your publication is nicely done, well written, and most of all inspiring. After reading Ellen Fullman's article on the Long String Instrument, I felt like rushing into the workshop and building one just to hear what it sounds like. However, there is some missing information (again) that would help. This concerns the rectangular soundboard 8" X 59". How thick is the soundboard, how closely spaced are the strings and how much tension are the strings under? All these questions concern themselves with how strong should the soundboard be. The photo on page 4 shows the strings disappearing into a very large board which I assume is not the soundboard. So where is it? And why the large board?

These questions aside, I am impressed with the thoroughness of the article and the whole newsletter in general. Keep up the good work. The "Recent Articles" column could well be the best part of the newsletter for we are always looking for other views, other approaches, other disciplines.

Stephen Smith

From the Editor: Some of the confusion over the specific dimensions, string spacing and so forth on the Long String Instrument stems from the fact that the instrument is still evolving. As it moves from one artspace to another for installation and performance it is frequently disassembled and re-assembled, and altered in the process to fit new spaces and incorporate improvements in design. The photograph showing the strings disappearing into a large board is of an earlier incarnation of the instrument which did use a larger soundboard (apologies for not indicating that clearly in the caption). The number and arrangement of the strings has also varied over time.

The current version, the one with the 8" X 59" soundboard, uses a spruce board approximately 1/8" thick, with a reinforcing strut of about 1/2" square by 4 feet long behind where the strings are attached. If this seems awfully light weight for strings of this size, remember that the frequencies it is intended to resonate are comparable to those of a guitar, which uses a similar spruce soundboard. The 8" X 59" board carries 28 strings in a horizontal line, arranged in two sets of twelve and one of four. Within each set the strings are an inch or so apart, with a much larger space between the sets.

Since string tension does not effect pitch in longitudinal vibration, the Long String Instrument only requires sufficient tension to hold the strings rigid and prevent their sagging under their weight and that of the clamps used for tuning. The soundboard arrangement described above, fragile as it may seem relative to the massive strings, can readily support this minimum of tension, though it does bow out a bit in practice.

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CORRECTION

In our last issue, in an article on the New Departures/Music concerts, we referred to the performing group "Totem" as "Richard Waters' group," inadvertently creating the incorrect impression that Richard Waters is the leader of the group. Totem is a cooperative effort and has no formal leader. Apologies to all concerned.

EXPERIMENTAL MUSICAL INSTRUMENTS
A Newsletter for the Design, Construction and Enjoyment of New Sound Sources

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THE BI-LEVEL GUITAR
(continued from page 1)

the upper. The strings join the soundboard at this sloped portion, crossing the saddle and going directly into the soundboard, without a conventional bridge between saddle and board.

The idea behind these innovations was that the angle of entry of the strings and the more direct coupling with the soundboard would make for a more efficient transmission of energy. The bends in the soundboard have the additional effect of making it more rigid without making it any thicker, again increasing responsiveness. The resulting instrument differs from conventionally-built guitars not only in total sound energy produced, as measured in decibels, but also in distribution of sound energy through the spectrum. This distribution effects perceived loudness as well as tone, as the following article makes clear. The sound differs also in its envelope, with a quicker attack and an altered decay pattern.

The author of the article, David Marriott, is a classical guitarist with a Ph.D. in experimental music from the University of California at San Diego. His affiliation of several years with the new instrument and its creators allows him to write about it with some authority; on the other hand, it might be feared that that closeness could bias him. So please allow me to insert my certified unbiased opinion here. I have played two of the bi-level guitars. I can unhesitatingly confirm, subjectively at least, all of Marriott's observations on the new instrument. Of the guitar's dramatically increased volume, brilliance, and speed of response, there can be no doubt for anyone who has played it. I should also mention that despite the differences in sound envelope and overtone distribution mentioned above and in Marriott's article, the sound of the instrument is unmistakably that of a classical guitar, only louder and more brilliant.

The strangest of part my experience with the new instrument was picking up my own classical guitar after playing the bi-level. I actually thought there must be something wrong with my old friend. Following the other it felt like some kind of rubber-bands-and-shoe-box contraption.

Anyone wishing to know more about the bi-level guitar or the lab tests and analyses discussed in the following article should contact La Jolla Luthiers & Mfg. Co. at 5418 Linda Rosa Ave, La Jolla, CA 92037; (619) 454-6966.

THE BI-LEVEL CLASSICAL GUITAR AN INTRODUCTION AND EVALUATION

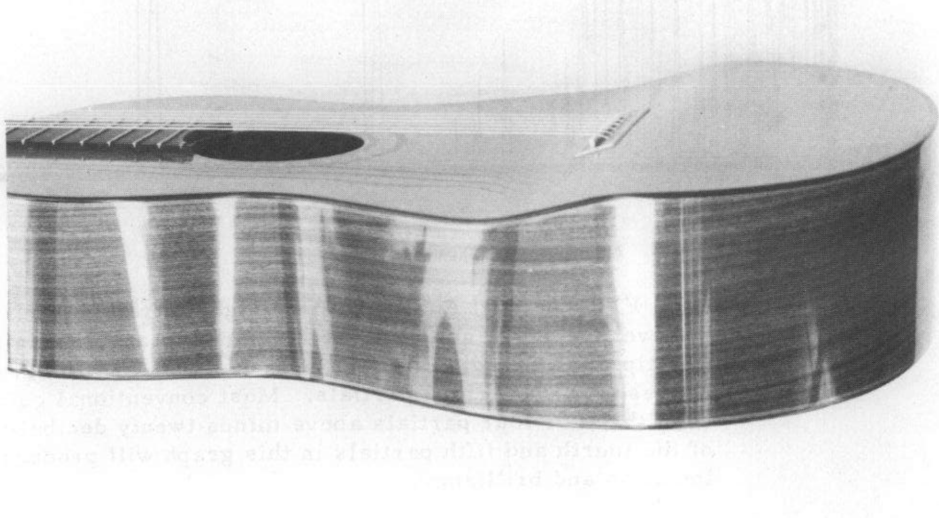
By David F. Marriott

The current trend in the construction and use of novel and experimental instruments has had little effect on the design of the so-called modern classical guitar. The shape and size of the guitar has remained relatively constant for over 100 years. In fact, the only changes that have occurred involve subtle variations in the bracing, coupling the strings and the neck, and the introduction of nylon strings in the 1940s. Recently, however, there is a new guitar design that has emanated in the community of La Jolla, California, appropriately referred to as the bi-level guitar. After seven years of covert development the bi-level guitar was introduced to the public in the Spring of 1985. Since that time, the new instrument has already gained a reputation as being one of the most revolutionary guitar designs of the century.

The concept of a curved two-level soundboard was conceived by Roger Pytlewski in 1978. He introduced the idea to his close friends and amateur guitar builders Wayne M. Harris and David Millard. Without delay, Harris began drafting the specifications for the new instrument and soon constructed the first bi-level guitar. Millard became enthused and proceeded to collaborate with Harris on the development of the second and third prototypes. Contributions to the development of the bi-level guitar were later provided by luthiers Robert L. Mattingly and David L. Dart.

According to Pytlewski, the primary purpose of his patented invention was to created a louder and more brilliant sounding guitar; one that could audibly compete with orchestral instrument without

BI-LEVEL CONCERT GUITAR BUILT BY DAVID MILLARD.



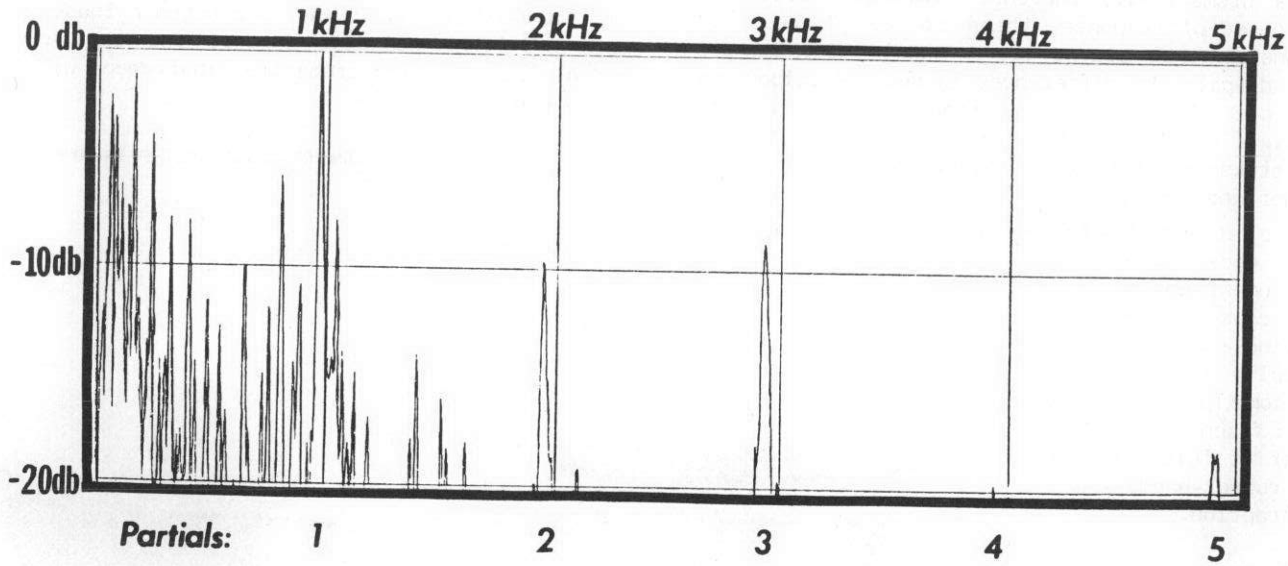
amplification. He believed that more sound energy would be transmitted into the soundboard if the strings entered at an angle directly into the top. This concept occurred to him after viewing the angle in which the strings of a harp enter its soundbox. Consequently, he hypothesized that a curved two-level soundboard on a guitar would simulate the angle of a harp's strings and probably accept the sound more readily than a conventional guitar.

In the autumn of 1983, plans were made to produce computer data that would quantify certain characteristics of a bi-level guitar's sound. Computer tests were conducted with bi-level guitars at Brigham Young University, Provo, Utah (Physics Department), the University of California, San Diego (Center for Music Experiment), and at an Aerospace lab in Southern California. Overall, the data from each testing site confirmed that the bi-level guitar produced an unusual amount of loudness, intensity, and tonal response.

Professor E. Paul Palmer at Brigham Young University suggests that the loudness in the perceived sound of a bi-level guitar is related to its output of high frequencies. He pointed out that the new soundboard is driving partials at greater amplitudes up high where the ear is most sensitive, such as past 3,000 Hz. This effect may be visually observed by using a FFT (Fast Fourier Transform) Spectral Analysis Program. FFT tests at the University of California revealed that a bi-level guitar produces strong partials as high as 3,636 Hz from the instrument's lowest pitch E (80 Hz) and 4,864 from the instrument's highest fretted pitch B (960 Hz). This phenomenon occurred throughout the range of the bi-level guitars and often rated from 1,000 through 2,000 Hz more than the highest partials produced on various conventional concert guitars.

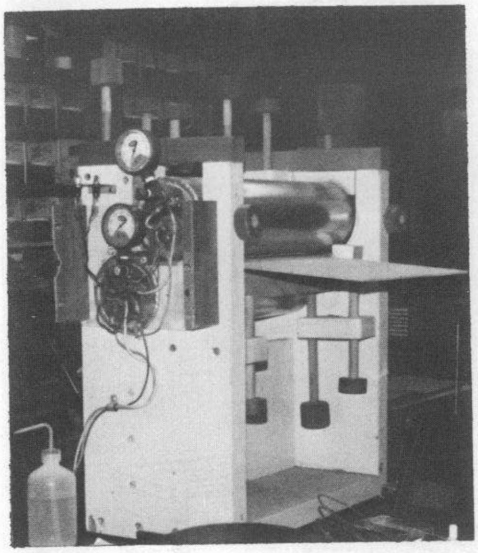
The results of the tests imply that the sensation of loudness from a bi-level guitar is largely due to its strong resonances in the region of maximum audible sensitivity, but its decibel output is also an effective element. Decibel tests at Brigham Young University have shown that a bi-level guitar prototype registered four through ten decibels louder than various conventional guitars (3 db is an apparent loudness difference in music, whereas 10 db will seem twice as loud). In addition, a sophisticated computer analogy of a bi-level guitar's design at an Aerospace lab indicated that any guitar with such a design would produce a louder sound with a quicker response. Thus, the high frequencies and quick response of a bi-level guitar are fundamental factors contributing to the instrument's noticeable loudness. This effect is physically caused by five basic structural categories: 1) the stiffness of the soundboard (due to its curve), 2) the angle in which the strings enter the soundboard, 3) the strings entering into and through the soundboard, 4) the juxtaposed contact of the saddle and soundboard, 5) the larger cavity of the lower bout.

Scientists, performers, and educators unequivocally agree that the new soundboard has created a louder sounding instrument. But, in addition to loudness, there are many elements that make up a "good sounding" guitar, such as timbre, sustain, and balance. Although loudness has long been sought after by concert guitarists, luthiers will explain that if too much attention is given to one



FFT Spectral Analysis of the highest fretted pitch B (960 Hz) on a bi-level prototype guitar. The fundamental appears as the highest point (the tip of an acending line) at zero decibels. All other prominent points represent the overtone partials. Most conventional guitars rarely exceed three or four partials above minus twenty decibels. The appearance of the fourth and fifth partials in this graph will produce a sensation of loudness and brilliancy.

HEAT BENDING MACHINE DESIGNED AND BUILT BY WAYNE M. HARRIS. The soundboard is bent by heating water in two 8" diameter tubes. Harris has recently designed a new method of bending which uses heating irons rather than tubes.



element the others will suffer. Since the entire soundboard of the bi-level guitar has been altered, all parameters of the sound have been changed.

In regards to timbre, FFT tests have indicated that the overtones on a bi-level guitar are more evenly distributed than on its conventional competitors. But due to the nature of the design, the overtone distribution occurs very quickly with a short decay time, therefore effecting the sustain quality of the pitch. There is a prolonged audible sensation of sustain on a bi-level guitar because the sympathetic vibrations of open strings are set in motion very rapidly. Otherwise, on some bi-level guitars, there is an absence of sustain when all strings are dampened except the string being articulated. This deficiency usually occurs in the higher fretted registers and is being closely scrutinized by the developers. They believe that the absence of sustain is related to the way in which the neck is coupled to the body and the fan strutting and bracing systems. Robert Mattingly feels that the lack of sustain is because the sound energy is not being driven throughout the soundboard as evenly as it should be. He is presently attempting to eliminate this problem by varying the bracing and the coupling of the neck and body.

Reactions from people who have heard or played a bi-level guitar are as diversified as each person's individual preference in any guitar. However, nearly everyone has agreed that it is an idea well worth developing, including internationally acclaimed guitarists Elliot Fisk and Michael Lorimer. Fisk believes that the new concept may possibly become a standard feature on all guitars. Contrarily, the general criticism that a bi-level guitar has received is that it lacks the "sweetness" that is so inherent of the Spanish guitars. It is true that a bi-level guitar produces a different sound, more like the sound of a harp, but any lack of sweetness should be attributed to the string energy being dumped out very quickly, the absence of sustain in higher registers, and the fact that the concert bi-levels are very young instruments.

The developers of the bi-level guitar have never intended to fabricate their new design in order to simulate the sound of a conventional guitar. Their main concern has been to create a louder instrument without sacrificing other sound qualities. Since 1981, ten prototypes, three concert models, and four steel-string bi-level guitars have been made by five different guitar builders. Each instrument has improved significantly through the years and arrangements are now being made by La Jolla Luthiers & Mfg. Co. to market the instrument by mid-1986. The fate of the bi-level guitar will most likely depend on the use and potential of the instrument in solo and ensemble music. Composers will have the opportunity to work with a different sound; a sound which will effect the use of experimental and extended techniques, the voicing of the instrument in solo compositions, and the scoring of the instrument in an ensemble situation.

****

BI-LEVEL CONCERT GUITAR BUILT BY DAVID L. DART. Notice the absence of any real bridge.

INSTRUMENTS

SLIT DRUMS AND BOOS
AND THE PROBLEM OF DESTRUCTIVE COMMUNICATION

The name "slit drum" usually refers to an instrument made up of an enclosed wooden resonating chamber with one or more cuts in the top. The cuts allow a portion of the top to vibrate somewhat independently from the rest of the instrument -- that is, independently enough so that it can establish its own rate of vibration, determined in part by the size and shape of the cut. It also functions as a soundhole over the resonating chamber. The simplest slit drums consist of a hollow log which is struck alongside a slit in the top with some kind of beater.

In recent years a number of people in this country have been making slit drums assembled box-like from pieces of milled wood. One sees these instruments frequently at crafts fairs and the like, often beautifully made from exotic hardwoods. They have anywhere from two to six or more tongue-shaped vibrating areas in the top piece, created by cutting jigsaw puzzle patterns or H-shapes with a sabre saw. I have asked a couple of the artisans that make them (a small and perhaps unrepresentative sample) how they decide how long and what shape to make the tongues, and whether they make any effort to tune them. The response has been that they are concerned with tone quality and appearance, but not with specific pitch relationships. Yet the tongues do produce definite, albeit random pitch. So the question arises: could one make a slit drum with many tongues tuned to a specific scale?

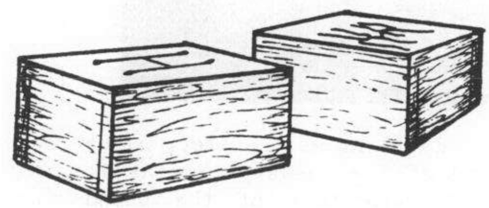
And the answer is: no, it doesn't work. CORRECTION! CHALLENGES MAY ARISE, BUT IT CAN BE DONE.

It is easy to make a slit drum with one tongue and tune it to a particular pitch, retaining the rich resonance characteristic of the instrument. After assembling the box and cutting the tongue, the pitch can be lowered in either of two ways: by extending the cuts alongside the tongue, in effect lengthening it, or by thinning it near the base by shaving wood off the underside. The pitch can be raised either by shaving the underside of the tip of the tongue, or by shortening it (this leaves an unsightly gap but does not harm the sound if one is not concerned with the tuning of the resonating chamber).

When you introduce more tongues, however, problems arise. The original tongue suddenly loses both its tuning and much of its resonance. Except in special cases, efforts to correct the situation by further tuning prove frustrating and the problem compounds itself as adjustments made on any one tongue persist in undoing the work that has been done on previously tuned tongues. This is because the tongues vibrate only partially independently of the rest of the instrument. Much of the vibration of any one tongue is communicated

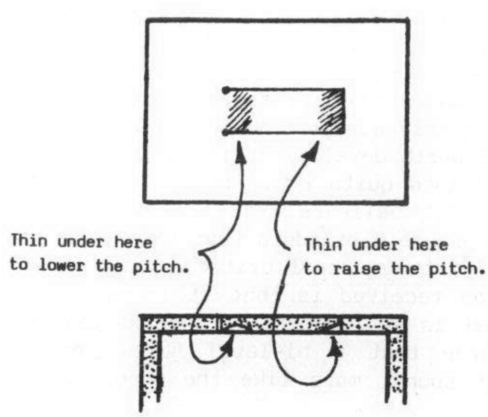
LOG DRUM

NORTH-AMERICAN-CRAFTS-FAIR-STYLE SLIT DRUMS



WHY NOT SOMETHING LIKE THIS?

TUNING THE TONGUE OF A SLIT DRUM



through the body of the instrument to the other tongues. In the special cases where the natural frequencies of the two tongues are identical or bear a simple integral relationship they will reinforce one another. But in most cases they will damp each other out or pull each other out of tune, or both.

(I should mention here that the hollow "thok" of a many-tongued slit drum, with its idiosyncratic overtone mix resulting from the interference between the tongues, often turns out to be a quaint and appealing sound in its own right. It can make for a lovely instrument, but one not readily tunable.)

The problem of destructive communication between vibrations of different frequencies arises in many instruments. It is the reason, for instance, for the seemingly arbitrary placement of the pitches in a Trinidadian steel drum, where the problem is alleviated by placing the most conflicting notes as far apart as possible. Even with the careful location of the sounding areas for the different pitches, this interaction probably remains a significant contributor to the pans' notorious difficulty of tuning, as well as to their characteristically irregular and inconsistent overtone recipe. (I find this inconsistency to be one of the steel drum's appealing features.)

The problem of destructive communication was also the downfall of a nail violin I once attempted to make. (The nail violin is an 18th- and early 19th-century European instrument made up of tuned metal spikes set in a wooden resonator played with a bow.) I found that any one nail could readily be made to speak, and could be tuned, within reason, to its intended pitch. But whenever I attempted to tune two adjacent nails a semitone apart, neither would cooperate. The one that had been tuned first would go out of tune and lose all its resonance; the second never would go in tune.

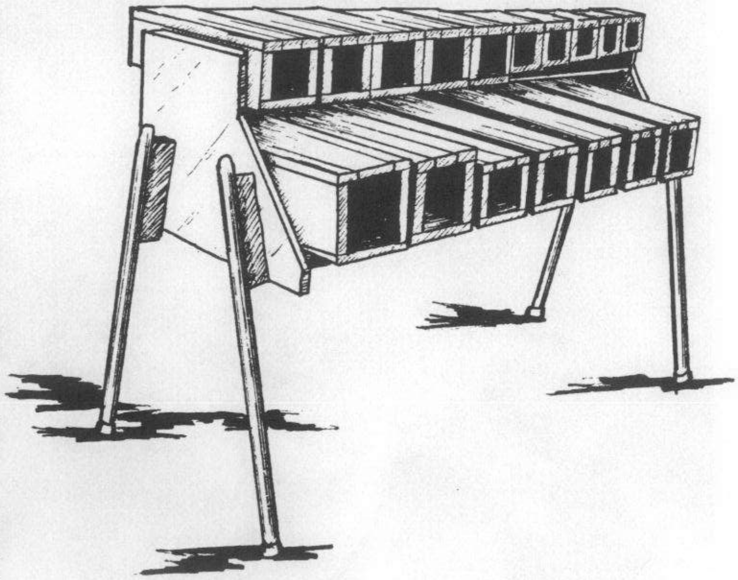
In instruments in which the connection between the initial vibrators and the resonating body is less rigid this problem does not arise, because there is far less communication from one vibrator to another through the body of the instrument. Thus, different strings of a piano can comfortably vibrate simultaneously at different frequencies without interfering with one another, since each string, free to flex at the bridge, can effectively ignore what the soundboard and the other strings are doing. The tongue of a slit drum, on the other hand, is an integral part of the whole top and rigidly connected to it. It must partake in any vibration occurring in the top, and through the top, in the other tongues.

There are a couple of less-than-ideal solutions to this difficulty. One could build a slit drum of very limited scale, tuning it to those intervals that reinforce one another. But this would be limited to a very few widely spaced tones. One could also try building a very large instrument and minimizing communication between the tongues of conflicting frequencies by their placement, as in a steel drum.

But by far the best solution, though it entails more work, is to build a battery of separate and independent boxes, allowing complete freedom in tuning. Each drum can then have two tongues tuned an octave apart. This system has the additional advantage that the resonating chamber of each drum can be individually tuned to agree with its tongue, enriching and prolonging the tone. Fitting one end of the box with a movable stopper like that of a tunable organ pipe would make the tuning of the resonating chamber accurate and easy.

A similar idea, in some ways simpler and more practical, appears in **Sound Designs** by Reinhold Banek and Jon Scoville (Berkeley: Ten Speed Press, 1980 -- a great book). "We were fooling around with possible variations of the slit drum" they say, "when we came upon this design. An open-ended box with a tongue at one end." They call the instrument Square Boos after Harry Partch's original boos, which also employed a tongue over an open-ended resonator, but were made of bamboo. The open-ended design reduces the amount of material and carpentry work required per box, and makes cutting the slits easier by eliminating the need for fancy sabre saw work. I might add that as with the slit drum a movable stopper for tuning at the closed end would be valuable.

For both the battery of slit drums and the square boos, mounting the boxes in a manner that holds them securely but does not kill the resonance is difficult. Banek and Scoville came up with a system in which the boxes are bolted in place, but with padded bolts on a foam cushion. They give details in their book. They also give more information on the construction of the boxes and provide a table of tongue and resonator lengths for a pentatonic scale.



SCOVILLE AND BANEK'S SQUARE BOOS (from a photograph in SOUND DESIGNS; used by permission).

HOLY CRUSTACEAN, BATMAN, THAT BEAST SINGS!

by Tom Nunn

What is 34" in diameter, flat, shiny with bronze antennae and balloon legs with bucket feet, and sings? You guessed it; the **Crustacean.** How did you know? Well, you may have run into one at some point (there are about twelve of them out there), but most likely you are wondering what the hell I'm talking about.

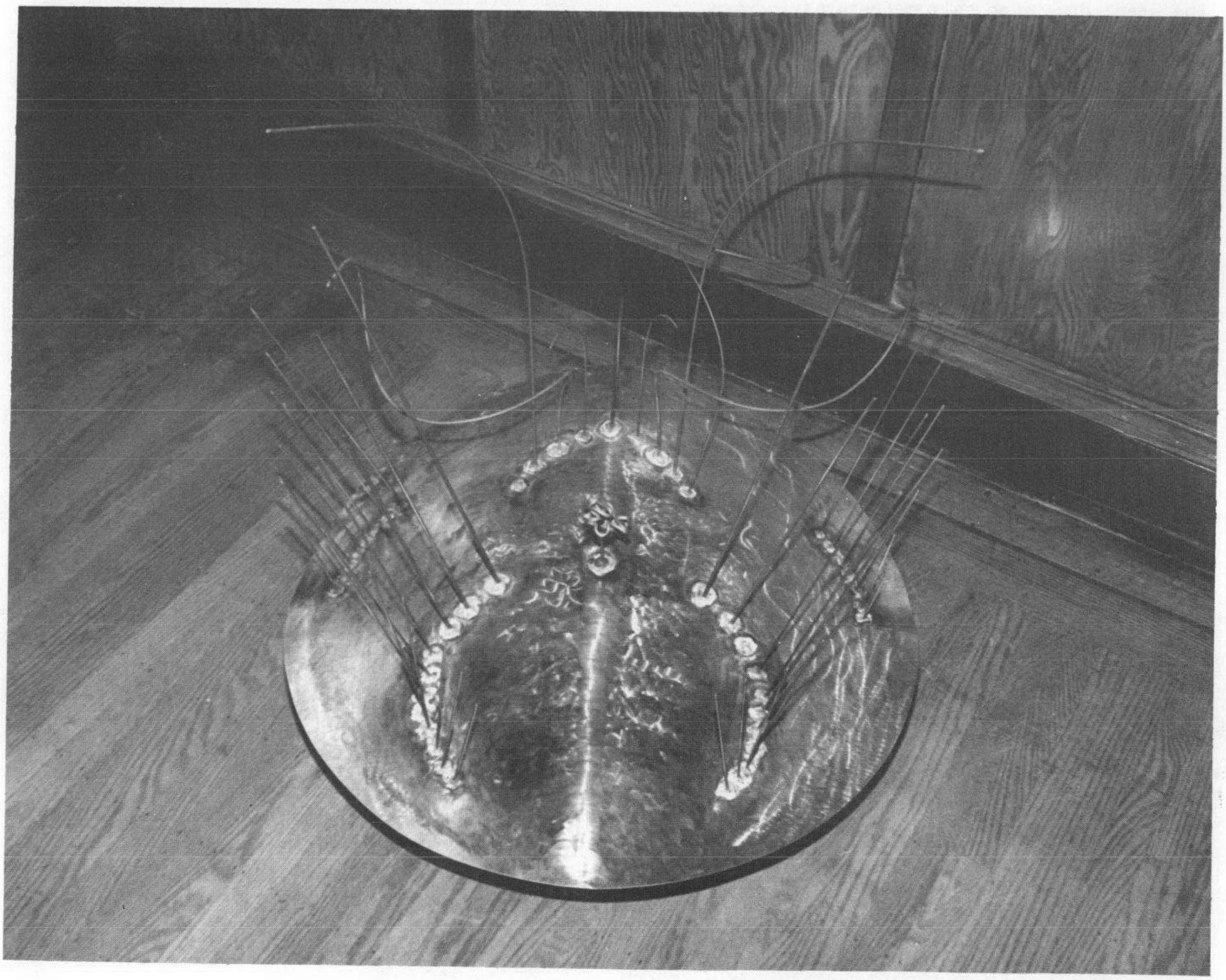
The Crustacean is, generically, what I call a "space plate." (I originally called them "balloon-mounted rodded metal sound radiators" or BMRMSRs for short, but it wasn't short enough!)

Space plates consist of (1) a steel (preferably stainless) plate, (2) bronze rods brazed to one surface of the plate, and (3) inflated toy balloons in small buckets used to support the plate in a table-like fashion. The balloons are highly elastic, allowing the plate to vibrate freely as the rods are bowed or struck.

The Crustacean, in particular, is a stainless steel disk with bronze rods supported by three inflated balloons. The sound of the Crustacean is extremely resonant. (One tone from a single bow stroke can sound for nearly a minute.) Two bows are used, one for each hand, and the placement of the rods on the plate is symmetrical, allowing two bowing trajectories for each hand. The rows of rods are curved for the same reason a bowed string instrument bridge is curved, so that one string (or rod) may be bowed at a time, or all bowed in a sweeping motion.

There is much variety in the timbre of the bowed rods. It is determined by their length, diameter and shape, along with the point of contact of bow on rod, bowing pressure and bowing speed. The instrument can be made to sound like a choir, a trumpet, or an electronic instrument; an explosion, or a traffic jam, among numerous other possibilities. In response to this newsletter's request for material relating to voice modifiers [**Experimental**

TOM NUNN'S CRUSTACEAN



Musical Instruments, vol I #1], I can add that the Crustacean is effective for resonating the voice to sound as if in a large cathedral. This is especially effective when amplifying the instrument (with a voice mike about 1/2" from the underside of the plate).

This instrument is hypnotic. Once one gets involved in bowing, it's difficult to stop. With its harmonic character, the Crustacean tends to take its own course, and the player goes along for the ride. I believe this happens because the harmonic combinations and changes are unpredictable, yet always harmonically related. Each rod is capable of from two to six or more different tones based on the fundamental and harmonics of the rod. The rods vibrate in sympathy with one another to such an extent that non-harmonic combinations of tones will not last, but will be superseded by harmonic ones. Let's say I bow a rod and let it ring, then bow a second rod whose tone is non-harmonic to the pitch(es) of the first rod. The second rod will either shift the sound of the first to one of its harmonics which is related to those of the second rod, or will dampen the first rod entirely. [Other manifestations of this acoustic phenomenon are discussed in the article "Slit Drums and Boos, and the Problem of Destructive Communication" appearing elsewhere in this issue.]

The harmonics of the rods are changed when the rod is bent or curved. The curved "antenna" rods have more harmonics than the short straight rods.

In 1981, Chris Brown and I were commissioned to build an instrument to be exhibited at the San Francisco International Airport during the New Music America '81 Festival. We built a space plate called the "Sun Sing Plate," which was an eight foot by three foot sheet of stainless steel with rods arranged in a sunburst pattern. This instrument was suspended along a wall and, because of its size, did not require balloons to maintain its resonance. However, when supported by balloons, its resonance is greater. Chris's **Wing** [see Recordings in **EMI** vol I #3] is a single balloon, wing-shaped space plate which uses tuned straight rods played with a double bass bow.

Most recently, I made another space plate using a five foot diameter steel picnic table -- the kind with the hole in the center for the umbrella pole. I've named this instrument the **Fleur d'Esprit**. It utilizes only straight rods, which are arranged on the plate to accommodate two players facing one another. It has somewhat greater resonance because of the larger, thicker metal plate.

There are many possibilities yet to be explored in the genre of space plates. Perhaps others will become interested in this idea and help further the cause of new music and experimental musical instruments.

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The Crustacean may be heard on the 1980 cassette tape **Earwig**, available from Chris Brown at 1951 Oak St. #4, San Francisco, CA 94117, for $8. For recordings of Nunn's more recent instruments, contact him at 3016 25th St., San Francisco, CA 94110.

NOTICES

A follow-up on the call appearing in the last issue for new instruments to be used in the upcoming Unifilms film score: Jack Adams of Unifilms reports that "we have gotten a great response from the newsletter readership and we appreciate everyone's interest."

The Music Department at Texas Tech University is seeking audio tapes (any format), texts, scores, or sounding gadgets that in any way relate to glass. They will be used for an audio tape to accompany an exhibit of glass sculpture by Anson Thomas at the Lubbock Fine Arts Center. Materials will be returned with documentation on the project. Send to SEND US GLASS, Dept. of Music, Texas Tech University, Lubbock, TX 79409. The deadline is 12/15.

Harvestworks is inviting artists working with audio as a creative medium to apply for studio production time to complete a new work in the Artist-in-Residence Program in Audio. The residencies will include full access to professional recording equipment and other materials needed for the project. Application deadline is 1/10/86. For more information contact Carol Parkinson at Harvestworks, Inc., A.I.R. Program, 16 W. 22nd St. (902) New York, NY 10010, (212) 206 1680.

ATTENTION 'HAMMERED' DULCIMER ENTHUSIASTS!! Subscribe to THE DULCIMIST -- the quarterly journal of dulcimer music, building and playing information, resources and much more. $12.00 yearly ($3.00 single issue). THE DULCIMIST, P.O. Box 1052, Williamsburg, KY 40769.

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COMING EVENTS

"Duos and Quartets: New Music from New Instruments," performed by Tom Nunn and Prent Rodgers, will take place on Saturday 12/7/86 at the New College Gallery , 762 Valencia St, San Francisco. Admission is $5. Sponsored by Ubu Inc. Call Tom Nunn at (415) 282-1562 for further information.

ARTICLES APPEARING IN OTHER PERIODICALS
(continued from page 16)

"DOWN MEMORY LANE: FORERUNNERS OF MUSIC AND THE MOVING IMAGE" by Reynold Weidenaar, in **Ear** Vol 9 #5, Fall 1985 (325 Spring St. Room 208, New York, NY 10013; $2/copy).

One section of this article might be very intriguing to new instruments people: it describes the turn-of-the-century performances of a woman who devised instruments to respond to her singing voice with the controllable creation of elaborate Chladni patterns (visual patterns created by the dancing of particles on a vibrating surface).

The same issue of **Ear** (see above) has a review of **Tracks 2**, a recording by Dutch composer and sound sculptor Relly Tarlo. The instrument recorded uses spheres rolling through suspended pipes of various lengths and diameters.

When I was in grade school I was taught, along with millions of other schoolchildren, that musical instruments are divided into four categories: strings, woodwind, brass and percussion. A lot of footnotes followed. Many woodwinds are not made of wood; many brass are not brass. Many members of the percussion family are not sounded by percussion. The piano, I remember being told, is really not a string instrument but a percussion instrument, because the strings are struck.

This bothered me. It makes just as much sense to reverse the statement, saying that the piano is really not a percussion instrument but a string instrument, because it has strings.

The problem here lies in the fact that the criteria used in delineating these classifications are not uniform from one category to the next. As a result they are not mutually exclusive. In one case the distinguishing feature is the nature of the initial vibrator (stretched strings). In two others it seems to be the material of which the body of the instrument is made (woodwind and brass), but is actually the method of exciting the vibrating medium (lip-buzzed instruments on one hand, and instruments using air blown over an edge or a reed on the other). In the case of the percussion instruments the nominal key is the method by which the player excites the vibration, but this criterion is so inconsistently applied that it really isn't worth much. In general usage the grouping ends up serving as a sort of catch-all for miscellany.

No one invented or devised this classification system. It came into being by a process of evolution in connection with the European orchestra. Over the years it has been called upon to absorb unforeseeable changes in the European instruments as well as Europeans' increasing awareness of non-European instruments, all the while accommodating people's natural conservatism in thought and language. The result is a rather sloppy system. There is no point in railing against it, but there is no point in hanging on to it either.

I don't know if they still teach this business to school children, but the fact is that better musical instrument classifications do exist. Devising coherent and effective taxonomies has been a favorite intellectual exercise among organologists over the years, and quite a few systems have been proposed. One of them has been accepted as the standard by most people working with musical instruments in a serious way these days. It is the Sachs-Hornbostel system, devised by Curt Sachs and Erich M. Von Hornbostel in 1914.

Sachs and Hornbostel did their work with museum curators in mind. Their immediate intention was to create a means for organizing musical instrument collections. Over the years their work has indeed proved valuable for that and similar purposes -- organization of instruments and information about instruments in museums, libraries, reference books, card catalogs and the like. But of greater benefit has been their system's providing better tools for talking and thinking about instruments. This is especially meaningful for people involved in exploring new sound sources. Having a coherent framework for thinking about musical instruments, one based upon rational analysis rather than tradition, enables one not only to look at existing musical instruments with a clearer eye, but also to envision possibilities for sound sources more readily.

People began to recognize the need to take a new look at musical instrument categorization a century ago. In 1888 the Belgian organologist Victor Mahillon, working with the large collection at the Brussels Conservatory, devised the method which was to form the basis for Sachs and Hornbostel's later work. Working with the same collection fifteen years later, Sachs and Hornbostel accepted Mahillon's most important ideas, but modified much of the detail work, in part because of an ethnocentric bias in the earlier system resulting from dependence upon European models. In 1914 they put forth their system in a piece in the Berlin anthropological journal, **Zeitschrift fur Ethnologie**, entitled "Systematik der Musikinstrumente. Ein Versuch." It was translated into English by Anthony Baines and Klaus Wachsmann, appearing as "Classification of Musical Instruments" in the Galpin Society Journal, Volume 14 in March 1961. The same translation has been reprinted in **The New Grove Dictionary of Musical Instruments** (New York: Grove's Dictionaries of Music, 1984), with portions appearing in the entry for "Classifications" and the remainder under headings for the four main instrument types (see below).

The Sachs-Hornbostel system has some shortcomings. The authors themselves comment in their introduction on the inevitability of the need for change and improvement as time passes and instruments evolve, and the word "Versuch" in the title of their article implies an exploratory rather than a definitive work. An overview of the criticisms of the system that were aired after the original publication appears in Jaap Kunst's **Ethnomusicology** (1953, 3rd edition, The Hague). A number of new classification systems designed to improve on Sachs-Hornbostel have been proposed, some of which are discussed in the box at right.

Still, in spite of the criticism and several attempts to build a better mousetrap, the Sachs-Hornbostel system remains the standard classification system for musical instruments today. For its basic elements have proven effective, it has been flexible enough to absorb changes in the world of instruments that it describes, and, in general, people are comfortable with it.

AN OVERVIEW OF THE SACHS-HORNBOSTEL SYSTEM

The Sachs-Hornbostel system creates a taxonomy similar in form to that of biological species. It begins with four broad classifications. Each of these is divided into several subclassifications which in turn are divided into still finer groupings. Increasingly specific instrument types are delineated as one proceeds through the strata of classification. The originators of the system carried it out to as many as nine strata in some

OTHER CLASSIFICATION SYSTEMS

Since Sachs and Hornbostel first published their musical instrument classification system in 1913, several attempts have been made to improve upon it. Some of these, such as those of Andre Schaeffner and Hans-Heinz Draeger, are essentially refinements of the Sachs-Hornbostel Systematik (Draeger: **Prinzip einer Systematik der Musikinstrumente**, Kassel: Baerenrieter, 1948; Schaeffner: **Origine de instruments de musique**, Paris: 1936).

Among systems that have broken away from the pattern the most widely recognized is Mantle Hood's "symbolic taxonomy," presented in his textbook, **The Ethnomusicologist** (New York: McGraw-hill, 1971). Hood's system is built around a set of elaborate symbolic diagrams representing individual instruments. Into these diagrams he attempts to incorporate as much information as possible, including the sociological position and function of each instrument.

Another new system has just appeared in the most recent issue of **Ethnomusicology** (Vol. 29 #2, Spring/Summer 1985; P.O. Box 2984, Ann Arbor, MI 48106), in an article entitled "A New Approach to the Classification of Sound-Producing Instruments" by Rene T. Lysloff and Jim Matson. Their method avoids the creation of broad categories, utilizing instead a set of thirty-seven universal organizational criteria which function in a multi-dimensional array. Individual instruments can be represented conceptually by sets of points in these arrays. (The ease with which computers can index bodies of information according to several different keys simultaneously has clearly played a role in this and other recent classification systems.) This approach allows for a broad range of criteria and greater consistency in their application. Like Hood, Lysloff and Matson incorporate into their scheme a lot of information regarding playing technique, social function and so forth. Since it is oriented to multidimensional relationships rather than categories, the system highlights relationships between diverse instruments which would be obscured by hierarchical divisions.

Traditional musical instrument classification systems have come into being in other cultures as well. The classical Chinese system looks to the material of which an individual instrument is chiefly made, creating eight groups along the lines of clay, stone, skin, calabash and so on. The ancient Indian system distinguishes four groups: string instruments; wind instruments; drums, tambourines and the like; and cymbals and gongs and such -- almost identical, you will notice, to Sachs and Hornbostel's chordophones, aerophones, membranophones and idiophones.

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cases; one could, if one chose, carry it further to create a more detailed taxonomy.

The entire system is codified using the Dewey Decimal System (commonplace now, but an exciting new idea at the time the classification was being devised). With it one can identify a particular category or instrument type using a number. This feature is not especially useful to most of us, but it does contribute to a satisfying sort of coherence to the system as a whole.

The first criterion of categorization for all instruments, corresponding to the first digit in the Dewey decimal number, is the nature of the initial vibrating body. Following Mahillon, Sachs and Hornbostel recognized four basic types:

1 - Idiophones: The initial vibrator is solid material which vibrates by virtue of its own rigidity (it is not stretched).

2 - Membranophones: the initial vibrator is a stretched membrane, such as a drum skin.

3 - Chordophones: The initial vibrator is a stretched string.

4 - Aerophones: The initial vibrator is air, either enclosed in a chamber or free.

Since Sachs and Hornbostel's time a fifth group has been added, suggested by Jaap Kunst and others and subsequently accepted by general consensus:

5 - Electrophones: The initial vibration is that of electrons in a wire.

Jonathan Glasier suggests that in addition to this group we separately distinguish electro-acoustic instruments, in which an initially acoustic vibration is somehow converted to electrical oscillation and amplified.

And though it is not generally included, it makes sense to add another group for the sake of completeness, which could be called --

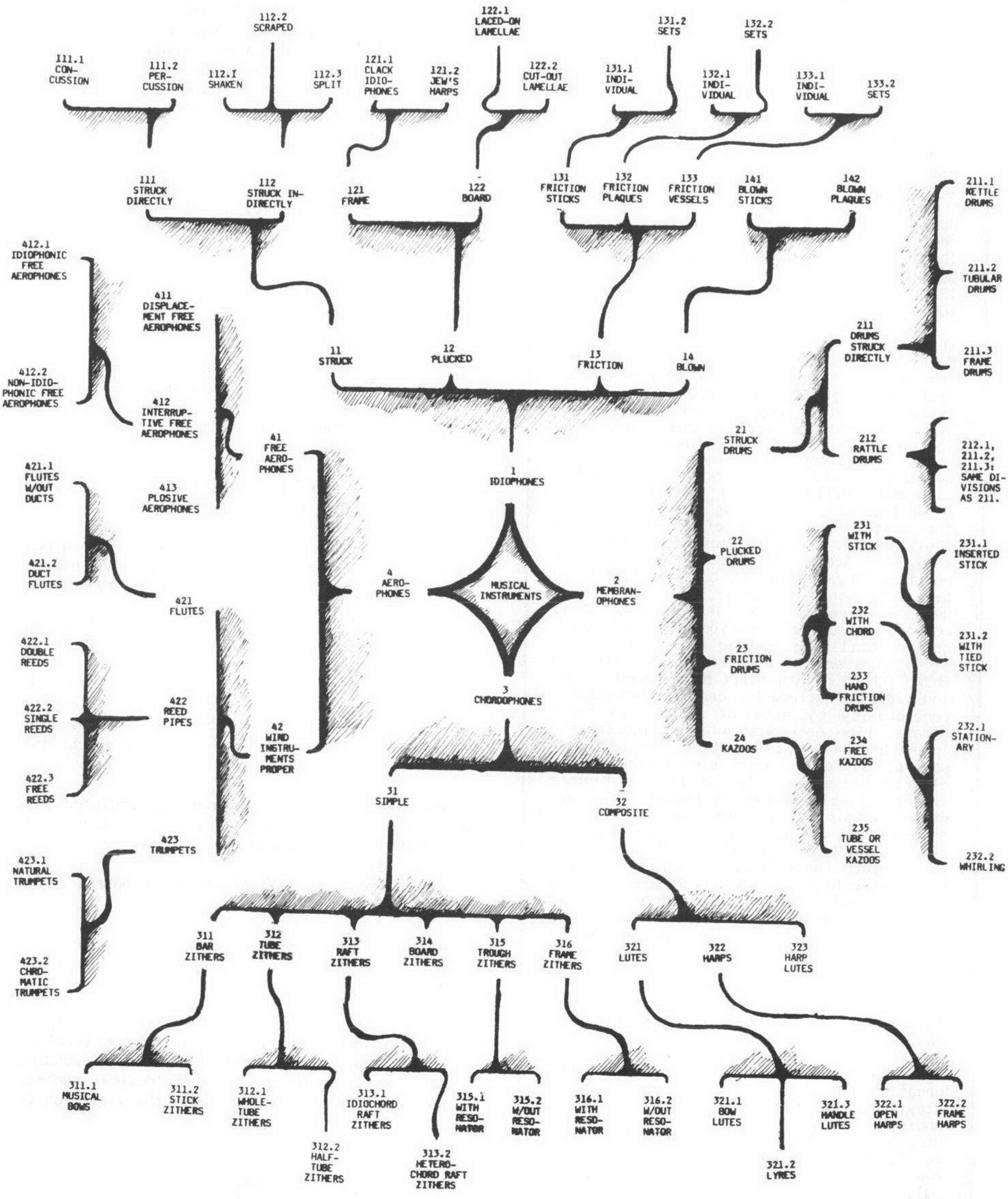
Hydrophones: the initial vibrating substance is liquid.

It is quite possible, of course, that more classifications at the first level will be called for in the future.

After this first level of classification the four original groups each follow their own pattern of subdivisions. For example, the second level of classification for the idiophones, corresponding to the second digit of the Dewey decimal number, is based upon the manner in which the vibration is excited:

11 - Struck idiophones
12 - Plucked idiophones
13 - Friction idiophones
14 - Blown idiophones

The membranophones similarly use the method of excitation in their second level of differentiation, but with the chordophones we look to the form of the instrument:



THE SACHS-HORNBOSTEL MUSICAL INSTRUMENT CLASSIFICATION SYSTEM

31 - Simple chordophones or zithers (no resonator or else a detachable resonator)
32 - Composite chordophones (with integral resonator).

And the aerophones are divided thusly:

41 - Free aerophones (no enclosed chamber)
42 - Wind instruments proper (the vibrating air is confined within the instrument itself).

To indicate characteristics which can be applied across several instrument types, each of the four main categories has a set of suffixes which may be appended to the Dewey decimal number for any instrument in that category. For instance, since many different idiophonic instruments are or could be operated by an automatic mechanism, the number 9 appearing as the last digit for an idiophone indicates that the instrument is mechanically driven. An eight indicates that it has a keyboard. For the chordophones the suffixes indicate the method of sounding the string:

-4 - Sounded by hammers or beaters
-5 - Sounded with the bare fingers
-6 - Sounded by a plectrum
-7 - Sounded by bowing

The chart on the facing page gives a partial representation of the Sachs-Hornbostel classification, following most of the instrument types through four levels of division and subdivision. Some of the terms that the creators of the system used are not immediately clear, but due to space limitations they are given here without definitions. For the complete system, look to the translation of the original article in the March 1961 **Galpin Society Journal**, available (possibly on microfilm) in large libraries, or to **The New Grove Dictionary of Musical Instruments**.

RECORDINGS

CAR HORN ORGAN/BROOKLYN BRIDGE
Wendy Chambers

A 7-inch, 45 rpm record, produced and distributed by Artmusic, Inc. (248 Sackett St., Brooklyn, NY 11231). Also available for $2.50 from New Music Distribution Service (500 Broadway, New York, NY 10012).

The Car Horn Organ is an assemblage of automobile horns -- two chromatic octaves worth -- designed and built by sound engineer Ted Sledzinski. The twenty-five horns are mounted on a framework of metal pipe. Electrical wires lead from the horns to a separate keyboard, set on a small table and played more or less like a conventional keyboard. The whole thing is powered by car batteries. Wendy Chambers performs four short pieces on side one of this disk: "The Star Spangled Banner," "Dixie," "When Johnnie Comes Marching Home," and an improvisation.

The great thing about this instrument is that it sounds exactly like a bunch of car horns doing "The Star Spangled Banner," "Dixie," and etcetera. The recording has the remarkable quality that no matter where you set the volume control, the music seems terribly loud. The unavoidable extra-musical associations enhance this impression.

The Car Horn Organ is tuned to a slightly unequal equal temperament, with some peculiar octave displacements. It would be interesting to know how this tuning was achieved -- was it simply a matter of finding available horns at the hoped-for pitches, or was some adjustment possible? The volume level varies considerably from horn to horn, creating a lot of unlikely accents in performance. This sometimes makes for a kind of hip and jazzy feeling, while at other times it creates an appealingly clownish effect. Chamber's performances include some two-part material, and the limited range and peculiar timbral qualities give the contrapuntal lines and almost-lines a disjointed, off-the-wall feeling.

The most interesting aspect of the Car Horn Organ's personality, of course, is this: each horn on the instrument has a <u>completely</u> different timbre from every other horn. There are irritating little Volkswagon horn sounds, self-satisfied Cadilac horn sounds, boomy-wheezing Mac Truck horn sounds. The mixture can make any melody quite comic. Beyond that, there is something of the wonderful unintentional color of human endeavor, the noise and commotion of the good old American melting pot, the awkward accidental parade of the every day life we tinkerers keep creating for ourselves, that comes across with an unexpected sort of appeal in this improbable juxtaposition of outrageous timbral personalities.

The irregularity of timbre merits some thought from a purely musical point of view as well. The tendency has existed in both Western and non-Western cultures to create groupings of like-sounding instruments. In European music this has partially broken down, yet we are still familiar with the impulse that long ago created families of like instruments for ensembles of uniform timbre. More recently, with the appearance of a number of found-object instruments and ensembles, I have noticed a similar inclination. Musicians confronted with a battery of kitchen utensils, inverted flower pots, springs, jugs and whatnot, will usually feel a need to organize it somehow. Most often the tendency is to do so by grouping like sounds or like sound sources. Why? Why not take a lot of random and varied found sounding objects, and organize them according to pitches and scales, without regard for sound quality? The effect of a coherent scale, sounding with wildly inconsistent timbre, would at the very least be quite interesting, and might be a real eye opener. With the Car Horn Organ, though the reasoning may be different, the results are much the same. The effect is, if nothing else, provocative.

Side two of Wendy Chambers' record is devoted to sounds of the Brooklyn Bridge. They were recorded on foot and in a moving car with a Nagra portable tape recorder, and transferred to the disk with a minimum of editing. If this sounds appealing to you, fine. If not, side one more than justifies the record's existence.

BOOKS

A SELECTED GUIDE FOR REFERENCE WORKS RELATED TO NEW INSTRUMENTS (BOOKS WORTH GETTING YOUR HANDS ON)

In the first issue of **Experimental Musical Instruments** we printed a reference guide of organizations and periodicals of potential interest to new instruments people. What follows here is a similar listing devoted to books. From the not-so-vast array of books that are valuable to designers, builders, players and aficionados of new instruments we have selected a small number of good basic resource materials and listed them with a brief overview of each. Most but not all of these works are still in print and available from the publishers. Large university or metropolitan libraries should have many of them as well.

In a future issue we will be running a listing, sans descriptive overviews, covering a wider range of more specialized works.

Naturally, the choice of resources presented here is subjective, and there may be important works that have not come to our attention. Please let us know if you know of other books that merit mention in **Experimental Musical Instruments.**

GENERAL BOOKS ON MUSICAL INSTRUMENTS

With one exception, the books dealing with musical instruments in general do a poor job as regards new instruments. There are quite a few that do well with traditional instruments, either European or of other cultures. Those given here are the most universal resources; any number of worthwhile books of less encyclopedaic scope could have been listed.

NEW GROVE DICTIONARY OF MUSICAL INSTRUMENTS, Stanley Sadie, Editor (New York: Grove's Dictionaries of Music, 1984. Three volumes, $350.)

This is the exception -- the best general resource, and the only one that is strong on 20th century instruments. It is new and completely up to date, and has a huge number of entries covering every imaginable instrument and related subjects. It is for the most part concisely and clearly written and, given the constraints of its encyclopedia-style format, fairly well illustrated. Because of its newness and its price, it remains hard to find.

MUSICAL INSTRUMENTS OF THE WORLD: AN ILLUSTRATED ENCYCLOPEDIA, by the Diagram Group (New York: Facts on File, 1976, $35).

Well-balanced geographically, but does not report on new instruments. It is valuable primarily for its wealth of illustrations, done in precise, readable, clutter-less line drawings. They make the book great for inspirational browsing. Drawings demand space though, and as a result the book is selective rather than complete in what it presents, despite its designation as an encyclopedia.

MUSICAL INSTRUMENTS: A COMPREHENSIVE DICTIONARY, by Sibyl Marcuse (New York: W. W. Norton & Company, 1975).

Useful primarily for scholarly purposes. It is very complete, with a huge number of entries. Descriptions are brief and there are no illustrations. Contemporary instruments are entirely omitted.

Marcuse also wrote A SURVEY OF MUSICAL INSTRUMENTS (New York: Harper & Rowe, 1975, now out of print), organized culturally rather than alphabetically.

GEIST UND WERDEN DER MUSIKINSTRUMENTE, REALEXIKON DER MUSIK INSTRUMENTE, and HISTORY OF MUSICAL INSTRUMENTS, all three by Curt Sachs. Published in various editions since first appearing earlier in this century, they are not currently in print but are widely available in libraries.

Curt Sachs remains the most widely read and respected early organologist. He was one of the creators of the Sachs-Hornbostel system of musical instrument classification discussed elsewhere in this issue. **Realexikon** is a dictionary (in German), now largely superseded by Marcuse's work. In the other two books Sachs presents his ideas on the historical development of musical instruments.

BOOKS ON NEW INSTRUMENTS

The book which provides an overview of contemporary musical instruments has not yet been written. (The closest thing to this currently in existence would have to be selected entries in the **New Grove Dictionary of Musical Instruments,** discussed above.) But there are many idiosyncratic, individualized books on new instruments. Most of these take the form of a collection of homemade-instrument plans created by the author-builder. Of the many fine collections-of-plans books, two are mentioned here, chosen in part for their emphasis on new or unusual instrument types.

SOUND DESIGNS: A HANDBOOK OF MUSICAL INSTRUMENT BUILDING by Jon Scoville and Reinhold Banek (Berkeley: Ten Speed Press, 1980, $6.95).

This is the best of the collection-of-plans books. Fun, imaginative, original and challenging ideas are presented in a manner that is lively and often humorous, but also purposeful, clear, and respectful of reader's intelligence.

VIBRATIONS: MAKING UNORTHODOX MUSICAL INSTRUMENTS, by David Sawyer (New York: Cambridge University Press, 1977).

Another collection of plans, with designs based on exotic, but already existing types.

GENESIS OF A MUSIC, by Harry Partch (New York: Da Capo Press, 1979, $9.50).

Harry Partch was first and foremost concerned with rational tuning systems. But he found he had no choice but to be a builder as well, and he is now better known for his esoteric instruments than for his reasons for building them. In this, his massive personal manifesto, he devotes several chapters to his instruments. The descriptions are detailed, the photographs excellent, the narrative

irrepressible, exasperating, and challenging.

ENVIRONMENTS OF MUSICAL SCULPTURE YOU CAN BUILD and SOUND SCULPTURE, edited by John Grayson (Vancouver: A.R.C. Press, 1975 and 1976. Out of print; available at some libraries).

These two books are badly designed; the material presented in a confusing and disorderly fashion. But they are full of information for which there is no other source. Sound sculptors like the Baschet Brothers and Harry Bertoia, to name just two important figures scarcely represented in print, appear here with descriptions and photographs of their work.

BOOKS ON MUSICAL ACOUSTICS

Specialized or technical works are not listed here. The titles given below provide readable overviews and are accessible, perhaps with a bit of effort in some cases, to readers without background in physics.

FUNDAMENTALS OF MUSICAL ACOUSTICS (New York: Oxford University Press, 1976, $19.95), and HORNS, STRINGS AND HARMONY (Garden City: Doubleday, 1960; reprinted by Greenwood Press in 1979), both by Arthur H. Benade.

Two very lucid and readable presentations of basic acoustical principles, comfortable even for those uncomfortable with math and physics.

MUSIC, PHYSICS AND ENGINEERING, by Harry F. Olson (New York: Dover Publications, 1967, $6.95).

A good overview for non-physicists, yet more complete and detailed than Benade's book mentioned above; also a bit more demanding.

MUSICAL ACOUSTICS: AN INTRODUCTION, by Donald E. Hall (Belmont, CA: Wadsworth Publishing Company, 1979).

Another respected introductory text.

ON THE SENSATIONS OF TONE AS A PHYSIOLOGICAL BASIS FOR THE THEORY OF MUSIC by Hermann von Helmholz (New York, Dover Press, 1954; widely available in libraries), first published in 1863.

The classic early compendium of acoustical knowledge, much of it arising from Helmholz's own research. It is still read today, and not only for historical interest.

BOOKS ON TUNING SYSTEMS

The recent interest in intonational systems other than twelve-tone equal temperament has not yet produced a good overview of the subject. A couple of earlier works, both to some extent limited by a bias toward twelve-equal, appear below. The best representative of non-twelve thinking remains Partch's **Genesis of a Music**, discussed above. Helmhotz's **Sensations of Tone**, likewise discussed above, also is an excellent source, though it makes for dense reading.

TUNING AND TEMPERAMENT: A HISTORICAL SURVEY, by J. Murray Barbour (East Lansing: Michigan State College Press, 1951).

Concise and informative.

INTERVALS, SCALES AND TEMPERAMENTS, by L.S. Lloyd and Hugh Boyle (Reprinted in 1979 by St. Martin's, New York).

A longer work with an odd mix of subject matter. Full of useful information though, including very complete tables of ratios, cents and such.

Listed below are selected articles of potential interest to readers of **Experimental Musical Instruments** which have appeared elsewhere in recent months. We encourage readers to clip or copy noteworthy articles and send them to EMI for mention in this space.

"NATIVE WOODWIND WOODS" by Casey Burns, in **The Lark's March Newsletter**, Winter 1985 (Newsletter put out by Lark in the Morning, a retail store specializing in unusual instruments, at Box 1176, Mendocino, CA 95460, (707) 964-5569).

This brief article gives information on several inexpensive and locally available hardwoods that work well in place of the exotic woods traditionally used in woodwinds.

"ON THE TONAL EVALUATION OF XYLOPHONES" By Ingolf Bork and Jurgen Meyer, in **Percussive Notes** Research Edition, Vol 23 # 6, September 1985 (Box 697, 214 W. Main St., Urbana, IL 61801-0697).

An acoustic investigation into wooden bar instruments, with suggestions as to the best tuning of partials in individual bars.

"AN INTERVIEW WITH KARLHEINZ STOCKHAUSEN" by Michael Udow, in the same issue of **Percussive Notes** as the above.

A large part of this interview is devoted to discussions of specially designed percussion instruments called for in Stockhausen's pieces, including modified cowbells, log drums, bells and membranophones.

"A JUSTLY-TUNED HARPSICHORD" by Norman Henry, in 1/1, Vol 1 #4, Autumn 1985 (published by the Just Intonation Network, 535 Stevenson St., San Francisco, CA 94103).

This article describes an alternative keyboard layout designed for a just scale of twenty-nine tones per octave.

"SOUNDED, SOUNDING, TO SOUND: SOUND AND THE SEDUCTION OF THE VISUAL ARTIST" by M. Vincent Bennett, in **High Performance** #31 (240 South Broadway, 5th Floor, Los Angeles, CA 90012, (212) 687-7362; $5/copy).

This is an essay on the evolution and increasing use of sounding elements in what previously were purely visual domains, and refers to several currently working sound sculptors.

The same issue of **High Performance** (see above) served as the Festival Catalog for New Music America 1985, and has information on the many events relating to sound sculpture and new instruments that took place there, including work by Christian Marclay, Bill and Mary Buchen, Gordon Monahan, Bill Fontana, Doug Hollis, David Moss, Bruce Odland, Jim Pomeroy, Daniel Schmidt, Robert Wilhite, and heaven knows how many others.

Also in that issue is a review of a concert (not part of NMA 85) by Arthur Frick, builder of the Beepmobile, Stomper, Chinese Ruler, and other musical/sculptural oddities.

"WHOMP WHIP MUSIC" by Peter Van Riper, in **Ear** Vol 10 #2, Nov/Dec 1985 (same address as above).

This brief piece contains a photo and an obscure description of an instrument made of suspended aluminum baseball bats by the article's author.

Artweek Vol 16, #36 (1628 Telegraph Ave, Oakland, CA 94612; $1.50/copy) contains photographs and descriptions of a couple of sound sculptures -- Robert Morrison's "River Thrum," an environmentally-activated wind and water piece made of steel, and Dan Ake's "Merry Go Round," a kinetic metal sculpture whose sounds are augmented by taped synthesizer sounds.

(continued back on page 9)

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